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Investigation on species abundance by catch per unit effort (CPUE) in Chalan Beel, Bangladesh

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Abstract
An assessment was carried out to investigate the species abundance by catch per unit effort (CPUE) in Ruhul Beel 1, 2 and Bamonji Beel 1, 2 under Chalan Beel in Pabna district of Bangladesh. Data were collected from selected sanctuary sites, focus group discussion, personal and group contract as well as Government and Non-Government organizations with prepared and pretested questionnaire. Total 38 species were observed in sample catch from RB-1 and RB-2 during the whole study period. Each of 38 species was not available during all the months in the sample catch. Some species were found during whole study period and some were not available in every month. The mean highest CPUE was observed in case of Badai jal and Khora jal in both Beels in both years whereas, the lowest CPUE was recorded in case of Dhundi and Borshi in both sites in both years. The CPUE was increased in RB for every gear and decreased in BB for every gear other than Dharmo Jal. There was a highly significant difference in total catch and CPUE among the sites ($P<0.001$), gears ($P<0.0001$), months ($P<0.001$) and years ($P<0.01$).

Keywords: Species abundance, catch per unit effort (CPUE), Chalan Beel

1. Introduction
Catch assessment is an observational process through catch monitoring by a regular visit on the study spot survey for a sample of gear in an operation (Azher, 2009) [1]. There is a great contribution of selection of water body, geographical location and gear type on fish production, species richness, diversity, catch composition, species composition and distribution of the species (Kulbicki and Wantiez, 1990) [18]. The numbers or mean numbers of fish species may be statistically different due to the differences in bottom environment, depth of water, quality of bottom soil and shelters (Dugas and Debenay, 1980**)** [6]. The number of species as well as species richness may be varied due to deep or shallow waters or the variation in season (Rainer, 1984) [24]. The catch and species composition was observed in Chalan *beel* area which is comprised by a series of small depression of which each depression were a separate small *beel* (Sayeed, 2010) [26]. There are about 93 small Beels under Chalan *beel* area. Especially the small ditches inside the whole Chalan *beel* have been omitted for the study. There are so little works on this respect and has not been widely focused on understanding these patterns, with emphasis, among others, on the seasonal variation of fish abundance, species composition, biomass and ecological indices (Fischer and Eckmann, 1997; Grant *et al*., 2004; Gray *et al*., 2009) [7, 12, 13]. There are many differences in distribution of fish species among the rivers and the small ditches/*beels*/ depressions (Hossain, 2009) [15]. The distribution of fish communities, biomass and species composition fluctuates over space and time in the water-body (Matthews, 1998) [19]. The species composition of fishes and the abundance or biomass of several species or functional groups depends on human pressures (Mehner *et al.*, 2005; Zambrano *et al.*, 2006) [20,30] and planning of developing systems (Gassner, 2003; Moss *et al.*, 2003; Freund and Petty, 2007) [10, 21, 9]. The aim of the study was report on species and catch composition of fish species by CPUE.

Materials and Methods
Data Collection
The primary data was collected from selected sanctuary site and control site using various methods like baseline survey by transaction, focus group discussion, social mapping, wealth

ranking, mobility mapping, personal and group contract with prepared and pretested questionnaire etc.

The secondary data was collected from Department of Fisheries (DoF), Bangladesh Fisheries Research Institute (BFRI), Rajshahi University (RU), Dhaka University (DU) and Bangladesh Agricultural University (BAU) library, using internet and the selective fish landing centers in the study area.

Sample Gear Selection

Samples were taken from the catch by the local fishers from the selected Beel using different type of fishing gears such as nets (Badai jal, Current jal, Khora jal, Thela Jal, Dharmo jal), traps (Dhundi and Polo) and hooks (Borshi). Other than these gears fishers also fish by hand fishing and dewatering. In case of Badai jal, Dhundi, Khora jal, Thela jal, Dharmo jal and polo, every single gear was considered as one unit of gear. But in case of Borshi 100 pieces of dati borshi (hooks) were considered as one unit of gear. In case of Current jal every 75 feet of net was considered as one unit of gear because all the current jal was 75 feet long. On the other hand, in case of hand fishing and dewatering every individual fisherman was considered as one unit of fishing gear. Firstly, total gears or any other tools was observed and then sample fishing unit was selected by random sampling methods from the experimental site and name, total numbers of active gears, type of gear, date, duration of sampling, manpower involved in fishing and related other information about fishing practices and fishing tools were recorded during every sampling day. If the gears were more than 10 units then 5 units of gears were taken as sample gear and 3 gears from 5-9, 2 from 2-4 and 1 gear from 1 was selected as sample gear (JMBA, 1996) [16].

Catch Data and Species Count

The experiment was conducted for 24 months from May to April in Ruhul Beel and Bamonji Beel. The catch data collected by the local DoF office was used as the baseline data for estimating the yield of fish that is before the establishment of sanctuary. Data was collected weekly in each site starting from 6:00 am to 6:00 pm from the fishers catch. Two portable balances (weighing up to 0.01 gm) were used to weight the sampled catch. Total catch was taken including personal consumption. Time spent in fishing (time of collecting the observed fish, days per week, hours per day) was recorded too. Pretested survey forms were used to collect the data.

The catch record was taken gear-wise on weekly basis using structured format which contained the local name, common name, scientific name and catch weight of the respective species (Rahman MF *et al.*, 2010) [23]. The number of fish species was counted to estimate the catch composition, species composition as well as fish diversity of fish population, while the catch weight of fish offered a quantitative indicator of species biomass also related to the species composition, catch composition and fish diversity. The collected samples were sorted to species level (Kulbicki and Wantiez, 1990) [18]. The fishes were identified upto species level followed by Roberts (1995), Kapoor *et al.* (2002) and Haque (2014) [25, 17, 21, 4]. Each species was then weighted and counted one by one. If a species was represented by more than 200 individuals, the sample was then divided into sub-samples and from the divided sub-samples fish numbers were estimated by extrapolation (Kulbicki and Wantiez, 1990) [18]. The previously collected data by the local Upazilla Fisheries Office, Project office and Statistics office was used as baseline for the comparison with data collected in 1st year. On the other hand, data of first year was used as baseline to estimate changing trends of species composition, fish diversity and any other parameters of second year. Fish species composition and catch composition are usually expressed as the catch-per-unit-effort (gm/unit gear/hour). This term can be used to assessing the degree of exploitation of fishery resources (Degerman *et al.*, 1988; Ahmed and Hambrey, 2005) [4, 2].

Calculation

Total catch of fish and prawn was estimated from the data collected by catch assessment survey. To estimate the total catch, gear wise fish catch was recorded by calculating CPUE. The abundance and biomass of fishes are usually expressed as the catch-per-unit-of-fishing effort (CPUE). This is also used to assess the degree of exploitation of fishery resources (Degerman *et. al.*, 1988; Ahmed and Hambrey, 2005) [4, 2]. Total monthly catches for every gear type were estimated from their CPUE and average number of gears recorded monthly following a model equation (modified) developed by de Gaston and Spicer (2004) [11].

$$CPUE = S_c/S_g/T_s \times Td$$

Where CPUE = Catch Per Unit Effort for gear

S_c = Total sample catch (g)

S_g = Number of sample gear

T_s = Fishing time to catch the observed sampled fish (hour)

T_d = Total fishing time in a day (hour)

Total fish production was estimated according to Suwarso and Wasilum (1999) [28] and Solarin (1998) [27] with the formula:

$$\text{Total catch (T)} = h \times n \times CPUE$$

Where, CPUE = average catch per unit Effort for gear (in a month)

h = average number of fishing days per month

n = estimated average number of active or functional gear units

Catch-per-unit-of-fishing effort (CPUE) is usually used to express the abundance and biomass of fishes which is also used to assess the degree of exploitation of fishery resources (Degerman *et. al.*, 1988; Ahmed and Hambrey, 2005) [4, 2]. Catch per unit effort is the catch of fish by number or weight for a unit of fishing effort during a certain time. Here weight was considered to calculate the CPUE (gm/unit gear/day) for every unit of fishing gear (Sayeed, 2010) [26].

Statistical Analysis

Catches were analyzed separately for each season and the total number and weight of specimens up to species level were sorted and recorded. For each unit gear CPUE was calculated by body weight of the individual fish species. The numbers and weight of species caught per season and the one way Analyses of Variance (ANOVA) at 0.05 probability level in order to assess potential differences between the sample sites, years and fishing months were calculated by SPSS-20 and Office Excel program 2010. Correlation within different value and parameters were calculated using Pearson Correlation method. Inter annual catch changes of the species were tested by the catch Co-efficient of Variation (CV) within each year and months using the following formula;

CVm	=	Sm/Xm ×100 (among the months)
where Xm	=	mean of monthly abundance
Sm	=	standard deviation of monthly abundance
and CVa	=	Sa/Xa×100 (among the years)
where Xm	=	mean of annual abundance
Sm	=	standard deviation of annual abundance

Results

Frequency of Species in Sample Catch in different Months

Total 38 species were observed in sample catch from RB-1 and RB-2 during the whole study period. Each of 38 species was not available during all the months in the sample catch. Some species were found during whole study period and some were not available in every month. Such as *Danio rerio* was available in August to December in RB-1 and RB-2. In others month it was not available. It was also absent in BB-1 and BB-2. The distribution of species has been showed in the Table 1, Table 2, Table 3 and Table 4.

Table 1: Monthly distribution of fish species observed in sample catch from Ruhul *beel* (RB-1) during the study period from May- April

Name of Species	May	June	July	August	September	October	November	December	January	February	March
Denio rerio				+	+	+	+	+			
Puntius ticto							+	+	+	+	
Macrobrachium armatus						+	+	+	+	+	
Glossogobius giuris	+	+	+			+	+	+		+	
Wallago attu	+					+	+	+	+		
Catla catla						+	+	+			
Chanda baculis	+	+	+	+	+	+	+	+		+	
Chanda nama	+	+	+	+	+	+	+	+		+	
Chanda ranga	+	+	+	+	+	+	+	+		+	
Chela bacaila					+	+	+	+			
M. lamarrei	+	+	+			+	+	+		+	
Puntius chola	+	+	+	+	+	+	+	+		+	
Esomus danrica	+	+	+	+	+	+	+	+		+	
Channa orientalis					+	+	+	+	+	+	
Mastacembelus aculiatus	+	+			+	+	+	+	+	+	
Mastacembelus pancalus		+				+	+	+		+	
Lapidocephalus guntea	+	+	+		+	+	+	+		+	
Puntius sophore	+		+	+	+	+	+	+		+	
Xenentodon cancila				+	+	+	+	+	+	+	
Puntius conchonius	+	+	+	+	+	+	+	+	+	+	
Colisa sota	+	+	+	+		+	+	+	+	+	
Colisa fasciatus	+	+	+	+		+	+	+	+	+	
Colisalalia	+	+	+				+	+		+	
Anabas testudineus	+	+			+	+	+	+			
Cyprinus carpio					+	+	+				
Amplipharyngodon mola				+	+	+	+	+		+	
Puntius guganio	+	+	+	+	+	+	+	+		+	
Badis badis	+	+	+	+	+	+	+	+		+	
Panchax panchax	+	+	+	+	+	+	+	+		+	
Puntius Phutuni				+	+	+	+	+			
Labeo rohita					+	+	+	+			
Heteropneustes fossilis					+	+	+	+	+	+	
Channa triatus						+	+	+	+	+	
Channa punctatus	+	+	+	+	+	+	+	+	+	+	
Mystus tengara	+	+	+	+	+	+	+	+	+	+	
Mystus cavasius						+	+	+		+	
Leiodon cutcutia		+	+	+		+		+		+	
Nandus nandus				+	+	+	+	+	+	+	
Species Count	21	21	19	20	25	36	37	37	13	30	
Total species = 38											

Table 2: Monthly distribution of fish species observed in sample catch from Ruhul *beel* (RB-2) during the study period from May- April

Name of Species	May	June	July	August	September	October	November	December	January	February	March
D. rerio				+	+	+	+	+			
P. ticto						+	+	+	+	+	+
M. armatus					+	+	+	+	+	+	
G. giuris	+	+	+			+	+	+		+	+
W. attu	+					+	+	+			
C. catla						+	+	+			
C. baculis	+	+	+	+	+	+	+	+		+	+
C. nama	+	+	+	+	+	+	+	+		+	+
C. ranga	+	+	+	+	+	+	+	+		+	+
C. bacaila				+	+	+	+	+			
M. lamarrei	+	+	+		+	+	+	+		+	+
P. chola	+	+	+	+	+	+	+	+	+	+	+
E. danrica	+	+	+	+	+	+	+	+		+	+
C. orientalis	+	+			+	+	+	+	+	+	+
M. aculiatus	+	+			+	+	+	+	+	+	+
M. pancalus		+				+	+	+	+	+	+
L. guntea		+	+	+	+	+	+	+		+	+
P. sophore	+	+	+	+	+	+	+	+		+	+
X. canchila				+	+	+	+	+	+	+	
P. conchonius	+	+	+	+	+	+	+	+	+	+	+
C. sota	+	+	+	+		+	+	+	+	+	+
C. fasciatus	+	+	+	+	+	+	+	+	+	+	+
C. lalia	+					+	+	+		+	+
A. testudineus	+	+			+	+	+	+		+	
C. carpio					+	+	+				
A. mola			+	+	+	+	+	+		+	+
P. guganio	+				+	+	+	+		+	+
B. badis	+	+	+	+	+	+	+	+		+	+
P. panchax	+	+	+	+	+	+	+	+		+	+
P. Phutuni			+	+	+	+	+	+		+	
L. rohita					+	+	+			+	
H. fossilis					+	+	+	+	+	+	+
C. triatus						+	+	+	+		+
C. punctatus	+	+	+	+	+	+	+	+	+		+
M. tengara	+	+	+	+	+	+	+	+	+		+
M. cavasius						+	+	+	+	+	
T. cutcutia		+	+	+		+		+		+	+
N. nandus	+	+		+	+	+	+	+		+	+
Species Count	21	22	19	21	28	37	37	36	15	29	25
Total Species = 38											

Table 3: Monthly distribution of fish observed in sample catch from Bamonji *beel-1* (BB-1) during the study period May- April

Name of Species	May	June	July	August	September	October	November	December	January	February	March
P. Ticto							+	+	+	+	
M. armatus							+	+	+	+	
G. giuris	+	+	+			+	+	+		+	
W. attu	+					+	+	+			
C. catla						+	+	+			
C. baculis	+	+	+	+	+	+	+	+		+	
C. nama	+	+	+	+	+	+	+	+		+	
C. ranga	+	+	+	+	+	+	+	+		+	
C. bacaila						+	+	+			
M. lamarrei	+	+	+			+	+	+		+	
P. chola	+	+	+	+	+	+	+	+		+	
E. danrica	+	+	+	+	+	+	+	+		+	
C. orientalis		+	+	+	+	+	+	+			
M. aculiatus		+	+	+	+	+	+	+		+	
M. pancalus	+	+	+	+	+	+	+	+		+	
L. guntea	+	+	+	+	+	+	+	+		+	
P. sophore	+	+	+	+	+	+	+	+		+	
X. canchila	+	+	+	+	+	+	+	+	+	+	
P. conchonius	+	+	+	+	+	+	+	+	+	+	
C. sota	+	+	+	+	+	+	+	+		+	
Colisa fasciatus	+	+	+	+	+	+	+	+	+	+	
Colisalalia	+						+	+	+	+	

Anabas testudineus	+	+	+	+	+	+	+	+	+	+	
C. carpio					5	+	+				
A. mola	+	+	+	+	+	+	+	+			
B. badis	+	+	+	+	+	+	+	+			
P. panchax	+	+	+	+	+	+	+	+		+	
P. phutunio				+	+	+	+	+			
L. rohita						+	+	+			
H. fossilis					+	+	+	+			
C. striatus						+	+	+	+	+	
C. punctatus	+	+	+	+	+	+	+	+	+	+	
M. tengara						+	+	+		+	
M. cavasius						+	+	+			
T. cutcutia					+	+	+	+		+	
N. nandus					+	+	+	+			
Species Count	21	21	21	20	24	33	35	35	9	24	
Total Species = 36											

Table 4: Monthly distribution of fish observed in sample catch from Bamonji Beel-*2* (BB-2) during the study period from May-April

Name of Species	May	June	July	August	September	October	November	December	January	February	March
P. Ticto							+	+	+	+	+
M. armatus							+	+	+	+	
G. giuris	+	+	+			+	+	+		+	
W. attu	+					+	+	+			
C. catla						+	+	+			
C. baculis	+	+	+	+	+	+	+	+		+	+
C. nama	+	+	+	+	+	+	+	+		+	+
C. ranga	+	+	+	+	+	+	+	+		+	+
C. bacaila					+	+	+	+			
M. lamarrei	+	+	+		+	+	+	+		+	+
P. chola	+	+	+	+	+	+	+	+			+
E. danrica	+	+	+	+	+	+	+	+			+
C. orientalis					+	+	+	+	+	+	+
M. aculiatus	+	+			+	+	+	+	+	+	
M. pancalus		+	+			+	+	+		+	
L. guntea	+	+	+			+	+	+		+	
P. sophore	+	+	+	+		+	+	+		+	+
X. canchila						+	+	+	+	+	
P. conchonius	+	+	+	+	+	+	+	+	+	+	+
C. sota	+	+	+	+		+	+	+	+	+	+
Colisa fasciatus	+	+	+	+		+	+	+	+	+	+
Colisa lalia		+	+	+		+	+	+		+	+
Anabas testudineus					+	+	+	+			+
C. carpio					+	+	+				
A. mola				+	+	+	+	+		+	+
B. badis	+	+	+	+	+	+	+	+		+	+
P. panchax	+	+	+	+	+	+	+	+		+	+
P. Phutuni	+	+	+	+	+	+					
L. rohita						+	+	+			
H. fossilis					+	+	+	+	+	+	
C. triatus						+	+	+			
C. punctatus						+	+	+			
M. tengara							+	+		+	
M. cavasius							+	+			
T. cutcutia						+	+	+			
N. nandus		+	+	+		+	+	+			
Species Count	17	19	18	15	16	32	35	34	8	22	17
Total Species = 36											

3.2 catch per unit effort (CPUE)

Average CPUE (gm/gear/hour) for all fishing gears varied widely by gears, months and also by years (Table 1 for RB and Table 2 for BB). The mean highest CPUE was observed in case of Badai jal followed by Khora jal in every site in both years whereas the lowest CPUE was recorded in case of Dhundi followed by Borshi in both the sites in both the years. It was also observed that the CPUE for every gear were remarkably higher in RB-1 except hand fishing in RB-2 (Table 1). But the rate of CPUE was decreased in BB-2 for every gear other than Dharmo jal (Table 2). Badai Jal showed the highest CPUE in RB and BB which varied from 334.76 gm to 3841.93 gm and 332.53 gm to 1744.78 gm, respectively. The lowest CPUE was found in Dhundi which was varied from 9.06 gm to 48.76 gm in RB and 3.79 gm to 32.88 gm for in BB. There was a highly significant difference (Table 7) in total catch and CPUE among the sites ($P<0.001$), gears ($P<0.0001$), months ($P<0.001$) and years ($P<0.01$).

The co-efficient of variaiton (CV) of CPUE of several gears (Badai jal, Borshi, Current jal, Dharmo jal, Khora jal and Thela jal) illustrated decreasing in RB (Table 5). On the other hand, the variability (CV) of CPUE in different gears (Badai jal, Borshi, Dewatering, Dhundi and Hand fishing) was increased in BB (Table 6).

Table 5: Statistical presentation of catch per unit effort (CPUE) characteristics of different gears in RB under Chalan *beel*

Gear	RB-1					RB-2				
	Mean	Std.	CV	Mini	Maxi	Mean	Std.	CV	Mini	Maxi
Badai Jal	1453.60	689.85	47.46	334.76	2285.86	1992.75	911.60	45.75	1176.24	3841.93
Borshi	20.90	6.49	31.05	6.88	39.43	37.48	8.41	22.44	18.76	62.24
Current Jal	25.45	13.28	52.18	5.95	60.21	157.57	750.75	476.45	11.87	4963.99
Dewatering	1231.88	704.77	57.21	524.74	2197.77	1275.42	876.09	68.69	344.81	2424.71
Dharno Jal	375.79	291.17	77.48	102.42	753.40	476.63	319.69	67.07	138.42	852.97
Dhundi	15.82	5.03	31.80	9.06	31.88	31.37	7.21	22.98	21.52	48.76
Hand Fishing	1192.43	266.20	22.32	814.68	1396.02	631.03	142.84	22.64	497.34	893.56
Khora Jal	1300.09	402.89	30.99	919.24	2249.95	1850.37	292.09	15.79	1470.30	2230.43
Polo	238.96	17.10	7.16	226.86	251.05	326.38	82.99	25.43	267.70	385.06
Thela Jal	194.69	122.75	63.05	89.71	402.06	366.02	111.58	30.48	188.00	521.02
Total	254.08	515.88	203.04	5.95	2285.86	345.91	721.78	208.66	11.87	4963.99

Table 6: Statistical presentation of catch per unit effort (CPUE) characteristics of different gears in BB under Chalan *beel*

Gear	BB-1					BB-2				
	Mean	Std.	CV	Mini	Maxi	Mean	Std.	CV	Mini	Maxi
Badai Jal	833.66	566.98	68.01	332.5	1825.9	808.04	561.46	69.48	298.26	1744.78
Borshi	15.1	7.7	50.99	3.99	34.11	13.64	7.69	56.38	2.03	29.13
Current Jal	16.99	12.54	73.81	3.45	62.93	14.02	9.32	66.48	3.35	50.24
Dewatering	408.58	25.79	6.31	370.6	427.32	131.43	40.42	30.75	80.41	207
Dharno Jal	90.61	38.76	42.78	44.78	144.95	121.41	42.63	35.11	80.28	186.52
Dhundi	15.93	6.15	38.61	3.79	25.9	14.93	7.6	50.90	3.85	32.88
Hand Fishing	453.74	48.25	10.63	405.5	520.48	140.61	28.64	20.37	113.86	189.76
Khora Jal	344.28	73.73	21.42	281.7	474.81	293.23	60.97	20.79	229.89	385.39
Polo	0	0	0	0	0	0	0	0	0	0
Thela Jal	66.14	35.09	53.05	30.45	127.05	57.94	17.14	29.58	40.47	83.94
Total	104.74	241.24	230.32	3.45	1825.9	81.13	210.72	259.73	2.03	1744.78

Table 7: Analysis of Variance (ANOVA) of the effects of Sites, year, months, gears and species on total fish catch and CPUE

Variable	By Total catch		By CPUE	
	F value	P value	F value	P value
CPUE *Site	19.545	0.000	30.727	0.000
CPUE *Gear	25.116	0.000	67.889	0.000
CPUE *Month	5.296	0.000	7.028	0.000
CPUE *Year	8.456	0.004	1.719	0.190

Discussion

In the present study, average CPUE for all fishing gears were fluctuated widely by gears, months and years which might be due to mesh size, species availability in the *beels*, variation of water level in different months, water quality, productivity, fishing pressure, fishers' preferences and seasonal changes of weather which is supported by the findings of Sayeed (2010) [26]. The mean highest CPUE was observed in case of Badai jal and Khora jal in both *beel*s in both years whereas the lowest CPUE was recorded in case of Dhundi and Borshi in both sites in both years. The CPUE was increased in RB for every gear and decreased in BB for every gear other than Dharmo jal. There was a highly significant difference (Table 7) in total catch and CPUE among the sites (P<0.001), gears (P<0.0001), months (P<0.001) and years (P<0.01). The highest number of fish species was caught by Dhundi (29) and lowest numbers were caught by Polo (5). The findings of the present study were more or less similar to the findings of Ahmed (2008) [3].

In case of RB the highest mean CPUE was observed in badai jal (1992.75 gm) followed by khora jal (1850.37 gm) and the lowest CPUE was observed in Borshi (20.90 gm). On the other hand, in case of BB the highest CPUE was observed in Badai jal (833.66 gm) followed by Khora jal (344.28 gm) and the lowest CPUE was observed in Borshi (13.64 gm). The present findings were within the range to the findings of Munir (2008) [22], World Fish Centre (2005) [29] and Francis and Berchie (2013) [8]. In case of Dhundi, Badai, Khora all though the numbers of species were more but weight was less because of the smaller size of fishes. From the overall study, it was found that the CPUE value was gradually increased in RB but decreased in BB. So the abundance and biomass of fishes in RB was increased and in BB was decreased. It might be due to the establishment of sanctuary in RB.

Overall yield was increased 1.94 times in RB by 1st year and 2.07 times by baseline yield whereas at the same time the yield was decreased 0.97 times in BB by 1st year and 0.89 times by baseline yield which was supported by the findings of Ahmed and Hambrey (2005) [2]. The yield was gradually increased in RB and vice versa in BB.

The yield rate of RB-1, BB-1 and BB-2 were lower than the average national *beel* yield (786 $kgha^{-1}$) whereas the average yield rate of RB-2 (1178.83 $kgha^{-1}$) was higher than the average national *beel* yield (DoF 2013). It might be due to the establishment of fish sanctuary in RB which was strongly supported by the findings of FFP (2005). The fish yield was gradually increased in RB which might be due to the establishment of fish sanctuary. This result was similar to the findings of Azher (2009) [1] and Rahman *et al.* (2010) [23].

Conclusion

There are a series of small *beel* under the Chalan *beel* which is quite different from biodiversity, water depth, hydrography,

physico-chemical characteristics and biological conditions. A total of 38 species were observed in sample catch from RB-1 and RB-2 during the whole study period. Each of 38 species was not available during all the months in the sample catch. Some species were found during whole study period and some were not available in every month. The mean highest CPUE was observed in case of Badai jal and Khora jal in both *beel*s in both years whereas the lowest CPUE was recorded in case of Dhundi and Borshi in both sites in both years. The CPUE was increased in RB for every gear and decreased in BB for every gear other than Dharmo jal.

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Conflict of interests
The authors declare that there is no conflict of interests regarding the publication of this paper.

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